Management of Nosocomial Urinary Tract Infections in Adult Patients

Paul P. Belliveau, PharmD, and Ronald J. DeBellis, PharmD

Abstract

- **Objective:** To review the literature on the management of nosocomial urinary tract infections (UTIs) and propose guidelines for their treatment.
- **Methods:** MEDLINE search for English-language articles published between 1966 and August 2004 using the medical subject heading “urinary tract infections” or “urinary catheterization” combined with the term “nosocomial infection” or “hospital-acquired infection.”
- **Results:** UTIs are common in hospitalized patients, accounting for approximately 25% to 35% of nosocomial infections. The risk of nosocomial bacteriuria is greatest in women and in patients who have urinary catheters. The medical literature does not provide clear direction regarding appropriate management of nosocomial UTIs. Our guideline recommends that in situations in which urine culture results are available, treatment is indicated if the patient has symptoms of a UTI. In the absence of symptoms, workup and treatment are dependent on whether there is a urinary catheter in place. Treatment is not recommended for asymptomatic catheterized patients (although clinicians may consider changing or removing the catheter) unless the patient is pregnant or scheduled to have an invasive urologic procedure. In the asymptomatic patient without a urinary catheter, the urine culture should be repeated. Therapy should be initiated for the female patient whose follow-up urine culture contains at least 100,000 cfu/mL of bacteria. For situations in which urine culture results are not available and a UTI is suspected, we recommend that clinicians obtain urine for urinalysis and culture. If the patient has symptoms that are consistent with a urinary source of infection and pyuria is documented, treatment is recommended.
- **Conclusion:** The literature provides little definitive guidance for the management of nosocomial UTIs. Further investigation is required in the areas of diagnosis, treatment, and prognosis.

Urine tract infections (UTIs) are among the most common infections occurring in hospitalized patients, accounting for approximately 25% to 35% of nosocomial infections in hospitals reporting to the National Nosocomial Infection Surveillance System [1–5]. They are also reported to be one of the most common causes of nosocomial febrile illnesses in internal medicine patients [6]. Such infections may extend a patient’s intensive care unit or overall length of stay by 1 to 4 days and add an additional $600 to $700 to the cost of a hospitalized patient’s care [7–10]. These additional costs are even greater in patients who develop urinary catheter–related bacteremia and approach $2900 per episode [8]. More importantly, nosocomial UTIs have a negative impact on outcomes, as they can directly cause and indirectly contribute to mortality in hospitalized patients [9]. The potential cost and patient care implications of such infections have prompted the development of guidelines and devices designed to minimize the impact of these infections in hospitalized patients [11–14].

Treatment of nosocomial UTIs is typically confounded by the presence of foreign materials (ie, a transurethral catheter) or the isolation of pathogens with reduced susceptibility profiles [15]. As such, guidelines that address the treatment of uncomplicated UTIs cannot be applied to such infections. Unfortunately, although there are easily accessible guidelines describing the management of uncomplicated UTIs [16,17], guidelines specific to the treatment of nosocomial UTIs are not as readily available. In this paper, we review the literature on this subject and present recommendations for the management of nosocomial UTIs in adult patients at our institution.

**Literature Review**

English-language articles in MEDLINE were searched using the medical subject heading “urinary tract infections” or “urinary catheterization” combined with the term “nosocomial infection” or “hospital-acquired infection.” Initial searches
spanned literature from 1966 to January 2003; subsequent searches extended this time frame to August 2004. References were also identified by review of citations from the retrieved literature and available tertiary infectious diseases textbooks. Literature published in abstract form only were not considered. Because our goal was to address the management of nosocomially acquired UTIs, we did not consider literature that focused on hospitalized patients with community-acquired UTIs or UTIs in patients who are chronically catheterized. These infections involve patients whose pathogens were present or incubating prior to hospital admission. We also limited our scope to literature involving adult patients.

Epidemiology and Etiology
The risk of nosocomial bacteriuria is greatest in female patients and in patients who have urinary catheters [17–27]. This latter factor plays a particularly important contributing role in the epidemiology of nosocomial bacteriuria, as 80% of such episodes occur in association with use of urinary catheters. An additional 4% of episodes occur after another form of urologic manipulation [19,27]. Episodes of bacteriuria not associated with some form of urologic manipulation may actually be incidental manifestations of the natural history of UTIs or transient bacteriuria in a population at risk for such findings (ie, ambulatory, aged, noncatheterized women) [15,28]. These epidemiologic figures are likely dependent on the prevalence of urinary catheter utilization and manipulation, as point prevalence studies in institutions with low urinary catheter utilization rates attribute as few as 50% of nosocomial bacteriuria episodes to the use of such catheters [29,30]. Among catheterized patients, the risk for a nosocomial bacteriuria increases as a patient’s length of stay and duration of catheterization increase [18–20,23–26,31–34]. During periods of short-term catheterization (<2 weeks) with closed urinary drainage systems, the average daily incidence of bacteriuria (10^2–10^3 cfu/mL) has been reported to be 3% to 8% per day [35–38]. Approximately one quarter of patients catheterized for 2 to 10 days will develop bacteriuria in the absence of systemic antimicrobial therapy [8], while at least 50% of patients (almost all in some studies) catheterized for 2 to 4 weeks are noted to have bacteriuria [21,34,35,37,39,40].

Among patients who develop nosocomial bacteriuria, 8% to 50% develop symptoms consistent with a UTI [19,25,37,38,41], and 1% to 8% are discovered to have bacteremia that can be attributed to this urinary source [19,27,29,38,41–44]. Notably, in the study that is most likely reflective of current medical care for catheterized patients, only 8% of patients reported subjective symptoms referable to the urinary tract (87% were able to respond to questioning), and concomitant bloodstream infections were observed in only 4 of 235 cases of nosocomial bacteriuria [41]. Although 71% to 86% of bacteriuria episodes occur in patients who have had urologic manipulation (usually urethral catheterization), the risk for secondary bacteremia is not increased with catheterization [27,42–44]. Rather, the apparent disparity is due to the fact that most episodes of nosocomial bacteriuria occur in association with urethral catheterization.

Among nonbacteremic patients with bacteriuria, a death rate of 1% has been reported [19]; when associated with a secondary bacteremia, mortality is approximately 13% [19,42]. A group of investigators has reported that the development of catheter-associated nosocomial bacteriuria is associated with an approximately threefold increase in mortality [45]. However, the study reported no explanation for this. The investigators admit that unidentified confounding factors may have contributed to this finding. Excess mortality associated with bacteriuria was not observed by the researchers in a more recent investigation [41].

Nosocomial bacteriuria typically involves a single pathogen (89% to 94% of episodes are monomicrobial) [25,41,45]. In studies involving patients hospitalized in North American institutions, gram-negative bacilli are the most commonly isolated bacterial pathogens, comprising 58% to 75% of isolates [5,26,46,47]. Among these isolates, *Escherichia coli* is most commonly implicated (24%–38%), followed by *Pseudomonas aeruginosa* (9%–18%), *Klebsiella pneumoniae* (8%–15%), Enterobacter cloacae (5%–9%), and Proteus species (4%–5%). Among gram-positive pathogens, enterococci comprise 17% to 24% of isolates while staphylococci are isolated in 7% to 8% of specimens [5,46–48].

Diagnostic Considerations
Available data are insufficient to establish evidence-based criteria for diagnosing symptomatic nosocomial UTIs. This is partly due to the fact that patients at greatest risk (patients with urinary catheters) often do not manifest symptoms of a UTI despite the presence of bacteriuria. This is further confounded by the fact that reports in patients with symptomatic nosocomial UTIs often provide few details regarding the observed signs and symptoms [19,25,37,38,41]. In the largest and most recent study of catheter-related bacteriuria (1,497 patients enrolled; 235 episodes of bacteriuria), Tambyah and Maki observed few differences between catheterized patients with bacteriuria and those without bacteriuria [41]. In the absence of nonurinary sources of infection, the proportion of catheterized patients with fever (temperature > 38.5°C) or localized urinary symptoms (local pain, urgency, dysuria) was not increased in the presence of bacteriuria. There was also no difference in the mean peripheral absolute white blood cell count. However, bacteriuric patients who were febrile did present with a higher mean maximum body temperature than the nonbacteriuric patients (38.1°C versus 37.8°C; *P < 0.01*).

Investigators have reported associations between the
presence and degree of pyuria and (1) the presence of significant bacteriuria and symptomatic urogenital infection in noncatheterized patients and (2) the presence of bacteriuria and fever in bacteriuric spinal cord injury patients with various forms of urinary drainage [49–52]. However, there have been few investigations into the association between pyuria and either the presence of significant bacteriuria or symptomatic urinary infections in patients requiring short-term catheterization. Musher et al reported that pyuria (>10 cells/µL) was usually present when catheterized patients had more than 10³ cfu/mL of bacteria in their urine [53]. This degree of pyuria was sensitive to the presence of bacteriuria (86%) but was less specific (73%). The absence of pyuria was a more useful finding than the presence of pyuria, as the positive and negative predictive values were 62% and 91%, respectively. Although this report provided some insight into the correlation of pyuria and bacteriuria in catheterized hospitalized patients, the study was limited in size (90 patients) and applicability (it included hospitalized male patients who had been catheterized for time periods of a few hours to more than 6 months).

A report describing a subgroup of patients from the study by Tambyah and Maki represents the largest investigation of the pyuria-bacteriuria relationship in hospitalized patients (n = 761) requiring short-term catheterization [54]. These investigators reported that the mean urine white blood cell count was significantly higher (71 versus 4 cells/µL; P = 0.006) in patients with bacteriuria (>10³ cfu/mL), particularly when the isolated organism was a gram-negative bacillus. However, the absolute level of bacteriuria did not correlate well with the absolute level of pyuria. The presence of greater than 10 cells/µL in the urine was an insensitive but specific finding (sensitivity and specificity of 37% and 90%, respectively). As observed with Musher et al, the absence of pyuria was a more useful finding than the presence of pyuria, as the positive and negative predictive values were 36% and approximately 90%, respectively.

The natural history and significance of various degrees of bacteriuria in catheterized patients has been investigated by Stark and Maki [55]. These investigators demonstrated that almost all catheterized patients, even those with as few as 100 cfu/mL of bacteria in their urine, will progress to high-level bacteriuria (>10³ cfu/mL) within 24 to 48 hours. Unfortunately, although there are data to support relationships between levels of bacteriuria and urinary tract symptoms in specific clinical situations, most notably in women with community-acquired UTIs [56,57], little data support such a relationship between bacteriuria and symptoms in hospitalized patients. Garibaldi et al found no association between urinary bacterial colony counts and the development of urinary symptoms among patients who developed bacteriuria after catheter insertion [38]. The lack of data to support such a relationship is consistent with the finding that catheterized patients with bacteriuria may not have clinical symptoms that distinguish them from nonbacteriuric catheterized patients [41].

The Centers for Disease Control and Prevention and several European infection control organizations have published definitions that are used for the surveillance of nosocomial infections, including UTIs [58,59]. Although commonality between the nosocomial UTI definitions does exist, several inconsistencies preclude development of a common definition for nosocomial UTI. According to the Centers for Disease Control and Prevention definition of symptomatic nosocomial UTI in adolescents and adults, there must not be evidence that the infection was present or incubating at the time of admission, and 1 of the 2 criteria below must be met:

1. Presence of 1 of the following (fever (>38°C), urgency, frequency, dysuria, or suprapubic tenderness) PLUS a urine culture of ≥10⁵ cfu/mL containing no more than 2 species of organisms

2. Presence of 2 of the following (fever (>38°C), urgency, frequency, dysuria, or suprapubic tenderness) PLUS any of the following:
   - Dipstick test positive for leukocyte esterase and/or nitrate
   - Pyuria (≥10 cells/µL or ≥3 cells/high-power field)
   - Organisms on Gram stain of unspun urine
   - 2 urine cultures with repeated isolation of the same uropathogen (gram-negative bacteria or Staphylococcus saprophyticus) with ≥10⁵ cfu/mL urine in nonvoided specimens
   - Urine cultures with ≤10⁵ cfu/mL of urine of a single uropathogen in a patient being treated with appropriate antimicrobial therapy

**Treatment Considerations**

**Symptomatic Nosocomial Bacteriuria**

Most episodes of symptomatic nosocomial bacteriuria are considered complicated UTIs because of the presence of patient and pathogen characteristics that increase the risk for treatment failure or relapse [60,61]. Since the majority of episodes occur in association with urethral catheterization [19,27], a known risk factor for infection, treatment failure and the chance for relapse are considered to be greater with such a catheter in place [60,61]. Additionally, exposure to antimicrobial agents and resistant hospital pathogens increases the likelihood that the etiologic organisms will be different and more resistant than the community-acquired urinary pathogens.
commonly implicated as the cause of uncomplicated UTIs [62–67]. Because of these factors, guidelines for the treatment of uncomplicated UTIs cannot be applied to the treatment of patients with symptomatic nosocomial bacteriuria. Despite the significance and impact of such infections [1–9], the current medical literature does not provide clear direction regarding their appropriate management (including which antibiotic therapies might be best for treatment) [61]. Nevertheless, it does provide some guiding principles to assist clinicians with catheter management and antibiotic choices.

Changing or removing a patient’s transurethral catheter is an intervention typically recommended in the management of symptomatic nosocomial bacteriuria [15]. Ideally, this recommendation would be supported by a sufficiently powered clinical trial in which hospitalized patients experiencing symptomatic catheter-associated bacteriuria are randomized to antibiotic treatment with catheter removal or treatment with no catheter removal. Although some data support such an intervention in chronically catheterized patients [68], such data are not available for hospitalized patients infected with typical gram-negative pathogens while being catheterized for shorter periods of time [15].

The rationale for catheter replacement in hospitalized patients involves concerns about bacterial biofilm formation. These biofilms consist of extracellular polymeric substances into which are embedded a community of bacteria that have a survival advantage over free-floating bacteria. Biofilms provide bacteria with a nidus whereby they are protected from white blood cell phagocytes and the shearing force of urine flow [69–71]. These bacteria can also more easily evade the action of administered antibiotics because of poor or delayed diffusion into biofilms. Additionally, organisms within these biofilms grow slower and can express and more easily transfer resistance mechanisms. Subsequently, the minimum inhibitory concentrations of free-floating and biofilm-contained bacteria may differ by as much 1000-fold [72]. Biofilm formation can begin shortly after catheter insertion, allowing bacteria to ascend the catheter and reach the bladder within 3 days [71].

If these concerns are enough to prompt replacement of a urinary catheter in a patient who requires continued catheterization, it is likely that catheter exchange alone is insufficient for resolution of bacteriuria. In a brief report by Rubin and colleagues, catheter exchange alone reduced the average bacterial colony counts, but 25 of 27 patients still had counts greater than $10^9$ cfu/mL immediately after catheter exchange [73]. Alternatively, Peloquin and colleagues demonstrated eradication of *P. aeruginosa* bacteriuria in 8 of 10 patients after administration of a single tobramycin dose followed by catheter exchange 4 to 6 hours later [74]. The postexchange urine showed an average colony count reduction of 77%, and bacteriuria resolution occurred at a mean of 22 hours after the tobramycin dose. Although it is logical to think that removal would prove to be a more useful strategy than catheter exchange, there are no published data comparing these interventions.

When choosing antibacterial therapy for UTIs in nonbactereemic patients, clinicians need to consider the urinary antibiotic concentrations. Cures are more likely to occur when these concentrations are sufficient to inhibit or kill the etiologic organism. Conversely, serum concentrations of the antimicrobial agent appear to be poor predictors of response in infections limited to the urinary system. In a population of 84 patients with chronic pyelonephritis, McCabe and Jackson demonstrated the probability of cure was 70% in patients with inhibitory urinary drug concentrations and the probability of failure was 100% in patients without inhibitory urinary drug concentrations [75]. These values for serum concentrations were 64% and 53%, respectively. Similar information was reported by Stamey and colleagues in a small study of outpatient UTIs [76]. The probability of cure was 90% in patients with inhibitory urinary oxytetracycline concentrations, and the probability of failure was 80% in patients without sufficient urinary drug concentrations. Cures were observed even though serum samples from these patients did not demonstrate inhibition of the infecting organism. These same authors reported similar findings in patients being treated with penicillin G or nitrofurantoin [77].

**Asymptomatic Nosocomial Bacteriuria**

The medical literature does not provide clear evidence-based guidance for the management of asymptomatic nosocomial bacteriuria, whether it occurs in the presence or absence of short-term catheterization. However, because nosocomial bacteriuria is more likely to be seen in the setting where a urinary catheter is in place [17–27], hospital-based clinicians are more likely to encounter asymptomatic nosocomial bacteriuria in association with catheterization.

Treatment of asymptomatic bacteriuria associated with short-term catheterization in specific scenarios is advocated by many authors in an attempt to prevent complications in high-risk populations [69,70,78–80]. Such treatment reduces the risk for preterm birth in pregnant women [81,82] and the risk for symptomatic infection in patients who are to have an invasive urologic procedure [83,84]; hospitalized patients with asymptomatic bacteriuria who fall into one of these categories should receive antibiotic treatment. Arguments have been made for treatment of asymptomatic bacteriuria in women (particularly elderly women) with bacteriuria that persists 48 hours after catheter removal, presurgery patients, and in patients with kidney transplants, diabetes mellitus, urinary tract abnormalities, mechanical prostheses, or an immunocompromised status [78,80]. However, data describing the ability of antibiotic treatment to reduce the risks imposed by
NOSOCOMIAL URINARY TRACT INFECTIONS

Urine culture results available
(100–100,000 cfu/mL)

No urinary symptoms

Suspected UTI
(urine culture results not available)

Obtain urine for:
• Urinalysis
• Culture + sensitivity

Does patient have symptoms AND pyuria (≥ 3 wbc/hpf)

Specific UTI treatment NOT recommended

Treatment NOT indicated; may consider change or removal of urinary catheter†

†Treatment may be considered for pregnant patients and those who are scheduled to have an invasive urologic procedure

Symptom workup

Cystitis
Dysuria
Urgency
Frequency
Nocturia
Suprapubic heaviness
Urethral pain
Gross hematuria

Pyelonephritis
Flank pain
CVA tenderness
Abdominal pain
Fever
Nausea/vomiting
Malaise
Headache
± Cystitis symptoms

• Elderly patients may only present with confusion, lethargy, delirium, or loss of interest in eating, drinking, or socializing
• Patients with catheter-related UTIs do not usually have common lower UTI symptoms but may have flank pain, cloudy urine, fever, or signs of urosepsis

Consider change or removal of catheter in catheterized patients

Empiric antibiotic selections (adjust doses for renal dysfunction)

Cystitis
Primary:
po: levofloxacin 250 mg qd
IV: levofloxacin 250 mg qd
Alternative:
po: cefpodoxime 100 mg bid
IV: ampicillin 1 g q 6 hr + gentamicin 1 mg/kg q 12 hr

Pyelonephritis
Primary:
po: levofloxacin 250 mg qd
IV: levofloxacin 500 mg qd
Alternative:
IV: piperacillin/tazobactam 3.375 g q 6 hr + gentamicin 1 mg/kg q 12 hr (or 5–7 mg/kg qd for urosepsis due to gram-negative organisms)

If enterococcus is suspected as primary pathogen (history of enterococcal UTI):
po: amoxicillin/clavulanate 875 mg bid (only 65% of E. coli susceptible to ampicillin)
IV: ampicillin 1 g q 6 hr + gentamicin 1 mg/kg q 12 hr OR piperacillin/tazobactam 3.375 g q 6 hr + gentamicin 1 mg/kg q 12 hr

Duration of therapy (if symptom source thought to be the urine):
10–14 days (mild–moderate illness)
14–21 days (severe/urosepsis)

Figure. Guideline for the management of nosocomial bacterial urinary tract infections (UTIs) in adult patients. CVA = costovertebral angle; TMP-SMX = trimethoprim-sulfamethoxazole.
asymptomatic bacteriuria in such patients are not currently available.

Treatment of asymptomatic bacteriuria is generally discouraged in the absence of specific risk factors, since spontaneous resolution may be observed in as many as two thirds to three quarters of patients (higher resolution rates may be observed in younger populations) within 2 weeks of catheter removal [85–87]. Although the rationale for this conservative approach typically includes the commonly expressed concerns with antimicrobial overuse (selection for resistant organisms, unnecessary drug exposure leading to avoidable drug reactions, the increased cost for potentially unnecessary drug therapies), there is currently no evidence to link these issues directly with antibiotic overutilization in this specific clinical setting. However, when these concerns are considered in the context of the low risk for complications posed to most patients with asymptomatic nosocomial bacteriuria and the chance for spontaneous resolution with catheter removal, the risk-to-benefit ratio appears to favor this approach.

**Guideline for the Management of Nosocomial Bacterial UTIs in Adult Patients**

At UMass Memorial Medical Center, a 325-bed tertiary care hospital in Worcester, MA, we developed a guideline for the management of nosocomial bacterial UTIs in adult patients (Figure). For situations in which urine culture results are available, treatment is recommended if the patient has symptoms of a UTI. As literature is not available to suggest that nosocomial UTIs present with symptoms different than community-acquired UTIs, we have assumed that symptomatic patients will demonstrate typical urinary symptoms [57]. In the absence of symptoms, workup and treatment are dependent on whether there is a urinary catheter in place. Treatment is not recommended for asymptomatic catheterized patients (although clinicians may consider changing or removing the patient’s urinary catheter) unless the patient is pregnant or scheduled to have an invasive urologic procedure. In the asymptomatic patient without a urinary catheter, the urine culture should be repeated. Therapy should be initiated for the female patient whose follow-up urine culture contains at least 100,000 cfu/mL of bacteria. Because of the lack of specific guidance from the literature for patients falling into this latter pattern, our approach was drawn from what is known about the natural history of bacteriuria in outpatient settings. When an asymptomatic woman has a urine culture containing no more than 10,000 cfu/mL of bacteria, a follow-up confirmatory culture will likely not contain a significant quantity of bacteria, and the initial result may be considered representative of contamination. Conversely, if the quantity of bacteria is at least 100,000 cfu/mL on 2 different specimens, there is a high likelihood that this represents a significant finding, and treatment should be initiated. Because contamination is less likely in men, 1000 cfu/mL of bacteria is suggestive of an infection in men [57].

For situations in which urine culture results are not available and a UTI is suspected, we recommend that clinicians obtain urine for urinalysis and culture. If the patient has symptoms that are consistent with a urinary source of infection and pyuria is documented, treatment is recommended. As suggested by Tambyah and Maki, the presence of 10 white blood cells/µL of urine is a sensitive indicator for the presence of bacteriuria. Our cutoff for significant pyuria is 2 to 3 cells/high-power field, a value that is generally considered equivalent to 10 cells/µL [51,57,58]. If the patient has symptoms suggestive of a urinary source without pyuria or pyuria without suggestive symptoms, treatment directed toward a UTI is not recommended.

Therapy for a nosocomial UTI consists of replacing the patient’s urinary catheter and initiating antibiotic therapy. The antibiotic choices listed in the algorithm are based on our hospital antibiogram for the most common uropathogens (Table), the ability of specific antibiotics to produce high urinary concentrations, and our available formulary antibiotics. Antibiotic choices at individual institutions may differ depending on antibiogram specifics and local contracts. The algorithm does make a qualitative difference in

---

**Table.** Antibiogram for Typical Urinary Pathogens at UMass Memorial Medical Center

<table>
<thead>
<tr>
<th>Susceptible, %</th>
<th>TMP/SMX</th>
<th>Ampicillin</th>
<th>Pip/Tazo</th>
<th>Ceftriaxone</th>
<th>Gentamicin</th>
<th>Levofloxacin</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E. coli</strong></td>
<td>85</td>
<td>65</td>
<td>93</td>
<td>100</td>
<td>97</td>
<td>96</td>
</tr>
<tr>
<td><strong>P. aeruginosa</strong></td>
<td>84</td>
<td>13</td>
<td>84</td>
<td>13</td>
<td>56</td>
<td>52</td>
</tr>
<tr>
<td><strong>K. pneumoniae</strong></td>
<td>83</td>
<td>2</td>
<td>69</td>
<td>89</td>
<td>88</td>
<td>83</td>
</tr>
<tr>
<td><strong>E. cloacae</strong></td>
<td>87</td>
<td>2</td>
<td>66</td>
<td>70</td>
<td>89</td>
<td>86</td>
</tr>
<tr>
<td><strong>P. mirabilis</strong></td>
<td>90</td>
<td>88</td>
<td>99</td>
<td>99</td>
<td>96</td>
<td>95</td>
</tr>
<tr>
<td><strong>Enterococcus sp.</strong></td>
<td>NR</td>
<td>85</td>
<td>NR</td>
<td>NR</td>
<td>42</td>
<td>1</td>
</tr>
</tbody>
</table>

NR = not reported; Pip = piperacillin; Tazo = tazobactam; TMP/SMX = trimethoprim/sulfamethoxazole.
the antibiotic choices depending on whether or not a urinary pathogen has been identified. In patients for whom an organism has not been identified, a more aggressive approach is recommended as an empirical approach is being utilized in these situations. One could also argue that the illness severity is likely to be greater in these patients.

The duration of therapy for nosocomial UTIs is another component of treatment poorly defined in the medical literature. Hence, our recommendations for therapy duration are based on what has traditionally been suggested for complicated UTIs by experts in this field [88].

Future Directions

As mentioned, there are numerous deficits in the medical literature regarding nosocomial UTIs. Further investigation is required in the areas of prognosis (i.e., evaluating the association between bacteriuria and mortality in specific patient groups), diagnostic evaluation (i.e., establishing specific criteria, determining the significance of the degree of bacteriuria), appropriate management (i.e., choice and duration of therapy, role and efficacy of catheter removal or catheter exchange), and economics (i.e., economic impact of specific management interventions).

Acknowledgments: The authors thank Kathryn Biery and Brian Marden for their literature search assistance in the preparation of this manuscript.

Corresponding author: Paul P. Belliveau, PharmD, Massachusetts College of Pharmacy and Health Sciences—Worcester, 19 Foster St., Worcester, MA 01608.

Funding/support: Financial support was provided by Ortho-McNeil Pharmaceuticals.

Financial disclosures: Dr. DeBellis is on the speakers bureau of Ortho-McNeil Pharmaceuticals.

Author contributions: conception and design, PPB, RJD; analysis and interpretation of data, PPB, RJD; drafting of the article, PPB; critical revision of the article, RJD; obtaining of funding, PPB, RJD; collection and assembly of data, PPB, RJD.

References

84. Olson ES, Cookson BD. Do antimicrobials have a role in preventing septicemia following instrumentation of the urinary tract? J Hosp Infect 2000;45:85–97.